1 Introduction

Airbus has developed the Runway Overrun Prevention System (ROPS) as a response to runway overrun events during the landing phase. The ROPS is presently being certified for the A380, under a new specific EASA performance regulation, in conjunction with the Brake To Vacate system.

Runway excursions during the landing phase now represent the largest category of accidents in air transport, amounting to approximately 20 percent of all reported occurrences.

This article will describe how the system:
- Keeps the pilots informed during approach, through its intuitive interface, so that they can better make the necessary decision on whether or not to go-around
- Assists and warns the crew after touch down on the necessary actions to reduce the risk of runway overruns, or to limit the overrun speed.

2 Main contributing factors

There are many contributing factors to runway overruns during the landing phase.

One of the major contributors has been and remains, unstable approach, to which the industry has responded by emphasizing training and procedures.

In an unstable condition, without actual information on the risk of a consequent runway overrun, the crew may be tempted to continue an approach in the belief that they may recover the situation, or that they have sufficient landing distance margins.

Other identified factors contributing to overruns at landing are:
- Wind shift at low altitude
- Long flare
- Long de-rotation
- Late selection of engine thrust reversers
- Cancellation of reversers at 70 knots
- Runway friction coefficient lower than expected (contaminated runway, snow, ice or runway more slippery than reported)
- Late/weak manual braking
- Technical failures affecting the landing distances during the landing (tyre burst, braking system failure…).
The Committee has now finalized its proposal for new regulation for in-flight landing distance assessment.

The ROPS computation algorithms are already consistent with these proposed regulation changes.

The content of these new proposals will be detailed in an article included in the next release of Safety First (issue #9) in January 2010.

Following in-service experience, the Certification Authorities have recognized the need to create new regulations for the in-flight computation of the Landing Distances published in the Airplane Flight Manuals.

This led to the creation of the Take-off and Landing Performance Assessment Aviation Rulemaking Committee (TALPA ARC), an industry group, in which regulators, airlines, airport operators, associations and manufacturers, including Airbus, were represented.

The ROPS represents a development of the Airbus Brake-to-Vacate (BTV) system.

During the approach preparation, the BTV automatically displays the landing distance that can be reasonably achieved, under normal operating conditions, on the selected landing runway. This landing distance is based on predicted data. If that runway’s Landing Distance Available (LDA) is lower than the displayed landing distance, initiating an approach is not advised, and a change of runway or diversion should be considered.

The automatic display of the operational landing distance allows the crew to select, during the landing preparation, a desired runway exit. An exit that provides an available landing distance shorter than the displayed landing distance achievable on a dry runway cannot be selected, as it would not be achievable in normal conditions.

During the landing roll, the BTV ensures that the aircraft is decelerated to taxi speed, when the requested exit is reached, while optimizing the deceleration profile.

The main advantages of this system reside in an increase in passenger comfort, combined with a reduction of brake wear and temperature, thrust reversers usage and runway occupancy time.

For a detailed description of the BTV, please refer to the July 2009 issue of the Airbus FAST magazine.

Airbus decided to use the BTV as the basis for the development of safety functions intended for the prevention of runway excursions.

The ROPS was born.
3 Description of the ROPS

The ROPS assists the flight crew, during the approach and roll-out, in preventing runway overruns.

The system integrates two functions:
- A warning function, called Runway Overrun Warning (ROW), which applies in flight and is go-around oriented.
- An active protection function, referred to as Runway Overrun Protection (ROP), which applies on ground and is stop oriented.

The following description assumes that the ROPS is working in BTV mode, as it allows the operation of all available system functionalities.

3.1 The Runway Overrun Warning

From 500ft Radio Altitude (RA) until Auto-Brake activation, the Runway Overrun Warning (ROW):
- Computes and displays predicted DRY and WET lines on the Navigation Display (ND)
- Triggers alerts in case of predicted runway overrun conditions.

3.1.1 ROW: The DRY and WET lines on the ND

The DRY line provides a landing distance that can be reasonably achieved, under normal operating conditions, on a dry runway. This distance assumes:
- A realistic manual or automatic landing, normal flare and de-rotation technique
change inserted in FMS for appropriate speed managed, RWY condition change), a quick new operational landing distance check is possible with minimal crew workload.

Below 500 ft RA
The computation of the DRY and WET lines is based on measured data, by computing the operational landing distance realistically achievable, in real time.

This landing distance is calculated by taking account of the aircraft weight, ground speed, wind conditions, landing configuration and vertical/horizontal trajectory with respect to the runway threshold.

Note: In Auto-Brake modes other than BTV, the DRY and WET lines are not displayed. On the A380 in BTV mode, the DRY and WET lines can be checked on the Navigation Display (ND)

Above 500 ft RA:
In PLAN mode and in Airport Navigation range, as soon as the landing runway is selected during the BTV preparation, then with BTV mode set.

Below 500 ft RA:
In ARC mode and in Airport Navigation range (below 5NM), with BTV mode set.

A deceleration equivalent to Auto-Brake in High mode
A realistic dry runway with normal rubber contamination
Idle reversers
Margins for the system’s accuracy.

Above 500 ft RA
The computation of the DRY and WET lines is based on predicted data, in the frame of the Brake To Vacate achievable operational landing distance check function described in the “From BTV to ROPS” box.

Whenever a significant change of conditions occurs after the Brake to Vacate preparation and operational landing distance check (TWR wind

Note: In Auto-Brake modes other than BTV, the DRY and WET lines are not displayed. On the A380 in BTV mode, the DRY and WET lines can be checked on the Navigation Display (ND)

Above 500 ft RA:
In PLAN mode and in Airport Navigation range, as soon as the landing runway is selected during the BTV preparation, then with BTV mode set.

Below 500 ft RA:
In ARC mode and in Airport Navigation range (below 5NM), with BTV mode set.

A deceleration equivalent to Auto-Brake in High mode
A realistic dry runway with normal rubber contamination
Idle reversers
Margins for the system’s accuracy.

Above 500 ft RA
The computation of the DRY and WET lines is based on predicted data, in the frame of the Brake To Vacate achievable operational landing distance check function described in the “From BTV to ROPS” box.

Whenever a significant change of conditions occurs after the Brake to Vacate preparation and operational landing distance check (TWR wind
3.1.2 ROW: The Runway overrun alerts

If the WET line moves beyond the end of the runway, it turns amber on the Airport Navigation Display and a “IF WET : RWY TOO SHORT” caution is displayed on the PFD.

If the DRY line moves beyond the end of the runway, the DRY and WET lines turn red on the Airport Navigation Display, and a “RWY TOO SHORT” warning is displayed on the PFD. In addition, a “RUNWAY TOO SHORT!” repetitive audio callout triggers below 200ft.
3.2 The Runway Overrun Protection

From Auto-Brake activation until the aircraft stops, the Runway Overrun Protection (ROP) will:
- Compute and display a stop bar on the Navigation Display
- Automatically increase the braking to maximum braking and trigger appropriate alerts under predicted runway overrun conditions.
This braking is equivalent to that developed in a rejected take-off by the Auto-Brake in RTO mode, which represents the maximum physical braking capacity of the system.

3.2.1 ROP: The stop bar on the ND

The green stop bar indicates the best possible estimation of the remaining landing roll-out distance, integrating the current aircraft ground speed, deceleration rate and distance to the runway end. It is continuously updated taking account of the actual braking conditions (runway friction and slope, thrust reversers, anti-skid, etc…).

3.2.2 ROP: Automatic braking increase and alerts

If the landing is performed despite the ROW warnings, or if the aircraft’s deceleration is not sufficient, the ROP stop bar will appear, or move, beyond the end of the runway. In this situation, the path and stop bar turn red on the Airport Navigation Display, and a “MAX REVERSE” warning is displayed on the PFD.

Max physical braking is automatically applied (if Auto-Brake or BTV selected).

In addition, a repetitive “MAX REVERSE!” aural alert is triggered if max reversers are not both selected. This message will be repeated until the crew selects both max reversers.

The “MAX REVERSE” warning remains on the PFD as long as the stop bar shows a runway overrun condition, whether or not Max Reverse is set.

If the stop bar still shows a runway overrun condition at 80 knots, a “KEEP MAX REVERSE!” audio callout is triggered once, to warn against undue Max Reverse de-selection as recommended in SOP.

Whenever the stop bar comes back inside the runway, and no longer predicts a runway overrun condition, the ROP reverts and allows normal BTV braking operation to resume.
Thanks to the runway shift function, the system is able to integrate a temporary change of available runway length (NOTAM, Land & Hold Short Operations for instance).

**Summary and way forward**

The Runway Overrun Prevention System proposed by Airbus, through the BTV/ROPS option on the A380, is a comprehensive tool to:
- Help the crew in the go-around decision making process, in flight
- Assist and warn the crew during the ground phase, on the required actions to reduce the risk of runway overruns, or limit the overrun speed.

The system is expected to be certified, under a new specific EASA performance regulation, by summer 2009 on the A380. It will be available through a software change.

In the near future, the protection offered by the ROPS will be available as well in manual braking mode. This “manual ROPS” is expected to be proposed on the A320 and A330/A340 families by 2011/2012.

The ROPS will be basic on the A350XWB.

The extension of the ROPS capabilities to contaminated runways is currently under study.
Safety First is published by the Flight Safety Department of Airbus. It is a source of specialist safety information for the restricted use of flight and ground crew members who fly and maintain Airbus aircraft. It is also distributed to other selected organisations.

Material for publication is obtained from multiple sources and includes selected information from the Airbus Flight Safety Confidential Reporting System, incident and accident investigation reports, system tests and flight tests. Material is also obtained from sources within the airline industry, studies and reports from government agencies and other aviation sources.

All articles in Safety First are presented for information only and are not intended to replace ICAO guidelines, standards or recommended practices, operator-mandated requirements or technical orders. The contents do not supersede any requirements mandated by the State of Registry of the Operator’s aircraft or supersede or amend any Airbus type-specific AFM, AMM, FCOM, MEL documentation or any other approved documentation.

Articles may be reprinted without permission, except where copyright source is indicated, but with acknowledgement to Airbus. Where Airbus is not the author, the contents of the article do not necessarily reflect the views of Airbus, neither do they indicate Company policy.

Contributions, comment and feedback are welcome. For technical reasons the editors may be required to make editorial changes to manuscripts, however every effort will be made to preserve the intended meaning of the original. Enquiries related to this publication should be addressed to:

Airbus
Product Safety department (GS)
1, rond point Maurice Bellonte
31707 Blagnac Cedex - France
Fax: +33(0)5 61 93 44 29
safetycommunication@airbus.com

Safety First
# 08 July 2009

Safety First is published by Airbus S.A.S
1, rond point Maurice Bellonte
31707 Blagnac Cedex / France

Editor:
Yannick Malinge,
Vice President Flight Safety
Nils Fayaud,
Director Product Safety Information

Concept Design by
MULTI MEDIA SUPPORT 20090563

Computer Graphic by Quat’coul

Copyright: GSE 420.0221/09

Photos copyright Airbus
Photos by
ExM: Hervé Berenger, Philippe Masclet, Hervé Gousset.
Photo copyright Germanwings
Computer rendering by ABAC

Printed in France by AMADIO

© Airbus S.A.S. 2009 – All rights reserved. Confidential and proprietary documents.

By taking delivery of this Brochure (hereafter “Brochure”), you accept on behalf of your company to comply with the following guidelines:

► No other intellectual property rights are granted by the delivery of this Brochure than the right to read it, for the sole purpose of information.

► This Brochure and its content shall not be modified and its illustrations and photos shall not be reproduced without prior written consent of Airbus.

► This Brochure and the materials it contains shall not, in whole or in part, be sold, rented, or licensed to any third party subject to payment.

This Brochure contains sensitive information that is correct at the time of going to press. This information involves a number of factors that could change over time, effecting the true public representation. Airbus assumes no obligation to update any information contained in this document or with respect to the information described herein.

Airbus SAS shall assume no liability for any damage in connection with the use of this Brochure and of the materials it contains, even if Airbus SAS has been advised of the likelihood of such damages.